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DETERMINANTS OF INDIVIDUAL  
AND GROUP PERFORMANCE

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Technical Monitors: R. Mark Patton, PhD

Trievie A. Tanner, PhD

H. Clayton Foushee, PhD

Ames Research Center

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Robert L. Helmreich, Principal Investigator

Department of Psychology

The University of Texas at Austin

Austin, Texas 78712

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PROJECT FOCUS

The work undertaken under NASA sponsorship involves a broad exploration of individual and group/organizational factors that influence performance in demanding environments such as space and air transport. During the period of this award, primary efforts were directed toward defining critical issues, developing new methodologies for the assessment of performance in such environments, and developing new measures of personality and attitudes as predictors of performance. The corpus of work has been published in archival sources and is available. Copies of the resultant publications are enclosed.

In summary, this period of activity resulted in substantial conceptual clarification of relevant issues for research and validation. It also resulted in the completion and validation of a reliable instrument to assess crewmembers attitudes regarding crew coordination and flightdeck management. Although not reflected in publications, major efforts in data collection to validate concepts were initiated. The results suggest that substantial improvements can be made in the prediction of performance and in the selection of crewmembers for aviation and space.

The present report summarizes work accomplished under three major headings: Conceptual Work, Empirical Work, and Future Directions. Publications and presentations resulting from the project are listed chronologically in Appendix A and will be referred to by number in the report.

In addition, partial support was provided for the doctoral dissertations of six graduate students at the University of Texas.

#### CONCEPTUAL WORK

Five monographs dealt with definition of conceptual and theoretical issues surrounding human performance. The first, (2), examined the capabilities and limitations of selection, and training as determinants of performance. The proposition was raised that some aspects of performance are determined by stable personality factors while others are influenced by attitudes regarding appropriate task behavior. The thesis was advanced that those components determined by attitudes are amenable to modification by training programs while those governed by personality will be highly resistant to change. This suggests that increased emphasis should be placed on personality factors in selection and research efforts should attempt to partition variance between personality and attitudinal factors.

A second paper, (8) examined specific issues in the use of personality measures in pilot selection. It was argued that, although personality traits have not proved successful as predictors of pilot performance, this failure is probably due to methodological problems in the choice of performance criteria (performance in training) and in the operationalization of personality assessment. It was suggested that renewed efforts should address the isolation of critical personality factors in crew performance (see also 11).

A paper originally presented at a NASA Conference was published in the American Psychologist, (3). This paper delineates social psychological issues likely to confront the U. S. Space program especially as it turns to longer duration missions in a space station. These include problems due to more heterogeneous crews, greater isolation, and organizational and managerial problems associated with isolated microsocieties.

Another monograph, (6) reviewed issues surrounding sex differences and sex roles. As both aviation and space activities are beginning to incorporate larger numbers of females, it becomes critical to address issues surrounding sex differences. A conclusion of the review is that women's personalities may, in fact, predispose them to higher performance in group endeavors than men, but factors involving sex bias continue to result in performance evaluated as less effective than that of males.

A final paper examined issues regarding the validity of personality measures employed in the research (4). The fact that many of the items composing this battery have considerable face validity was discussed along with implications for interpreting findings obtained.

#### EMPIRICAL WORK

A primary accomplishment during this period was the development of a new instrument, the Cockpit Management Attitudes Questionnaire, (5), that assesses crewmembers beliefs about appropriate management of the flightdeck of air transports. The twenty-five items cover the areas of leadership,

personal reactions to stress, and group atmosphere. The questionnaire has proved highly valid in subsequent research and has been administered to more than 10,000 pilots as part of the project. A second study using the instrument, (6), revealed that pilots differed significantly as a function of three factors: organization in which flying accomplished, crew position, and personality. A third study, (12), validated the attitude measure in line flight situations. In this study the attitudes were able to discriminate between pilots rated as effective and ineffective managers. Using fourteen of the attitudes in discriminant function analysis, ninety-four percent of the pilots were correctly classified. A fourth study, (10) applied the technique of cluster analysis to the set of attitudes and found that pilots in different crew positions demonstrated differing cognitive structures as reflected in how they organize attitudes regarding flightdeck management.

A second major theme of the empirical work was the refinement of personality measures for prediction of performance. A preliminary study, (1), reported significant prediction of pilots' line flying performance. The predictive measures reflect two core dimensions of the self - instrumental, goal oriented traits including components of achievement motivation and traits defining interpersonal orientation and expressivity. The operationalization of these traits includes both their positive and their negative aspects.

One of the puzzling aspects of personality research has

long been the fact that while personality traits are seen as major determinants of human behavior, much research has failed to show any relationship between personality and performance. In particular, research on pilot selection has failed to demonstrate that personality is a significant predictor of flying effectiveness. A recent study in the project, (11), suggests one resolution for this paradox. In this study, the performance of personnel was examined longitudinally, from their initial completion of training in a clerical position, three months later, and again after five to seven months. Consistent with earlier research, there were no correlations between personality and performance at the end of training. However, by three months on the job, personality performance correlations were significant and remained stable over time. This phenomenon has been christened the "honeymoon effect". The interpretation is that during initial training and enactment of a desired job, persons will try the hardest to perform well. Having successfully completed training, however, during routine task performance basic relationships between personality and performance begin to emerge. This finding has important implications for personnel selection and the choice of criteria for performance evaluation.

A final empirical study examined relationships between mood, sleep, fatigue in long and short haul flight crews operating jet transport aircraft. This study serves as a pilot investigation for a larger investigation which will relate

personality measures to these health and behavioral outcomes.

#### FUTURE DIRECTIONS

The research described above is being continued and extended as part of a Cooperative Agreement with NASA-Ames Research Center (NCC2-286). There are six primary tasks for the future: 1. Continue refinement of the personality measures employed and extend them to crew health issues as well as performance. 2. Continue to investigate relationships between the attitude measure and performance and personality. 3. develop new methodologies for assessing the performance and reactions of groups across time using systematic observational techniques and time series analyses. 4. Using a multivariate approach, examine the effectiveness of training in crew coordination as a function of organizational factors, personality factors, attitudes, and personal roles. It is hoped that this study will be accomplished using a number of major carriers in the civil air transport system as well as military crews in the Military Airlift Command. This is planned as a longitudinal study extending over a period of three to five years to provide the most valid and reliable findings. 5. Develop better methods for assessing the behavior of groups (as opposed to individuals). Because most of our society's emphasis is on the individual, work in evaluating group efforts has lagged. Most of the situations relevant to this project are highly interdependent with success depending on the coordinated activity of groups. Accordingly, this will have a high priority. 6. Develop a conceptual design for research

relevant to the performance and adjustment of crews in confined microsocieties such as a Space Station. Since very little solid data exist on how crews are likely to react in long duration spaceflight, this is a critical task. It is proposed that undersea habitats may be the most faithful analogs of the space situation. Plans will be developed to examine critical psychological issues in this setting. In particular, an observational methodology involving time series analyses will be developed.

This report represents an interim stage in an integrated program of research. Several disparate areas such as attitudes and personality were pursued during this phase. Initial work has begun on combining these characteristics to determine the extent to which each contributes to outcomes and what interactions may exist among them.



## Formal Publications resulting from NASA Grant NAG 2-137

1. Helmreich, R.L. (1982) Pilot selection and training. NASA/UT Technical report 82-1.
2. Helmreich, R. L. (1983). What changes and what endures: The capabilities and limitations of training and selection. In N. Johnston (Ed.), Proceedings of the Aer Lingus/Irish Airline Pilots Association Flight Symposium, Dublin, Ireland.
3. Helmreich, R.L. (1983). Applying Social in Outer Space: Unfulfilled promises revisited. American Psychologist, 38, 445-450.
4. Helmreich, R. L., & Spence, J. T. (1983). Beyond face-validity: A comment on Nicholls, Licht and Pearl. Psychological Bulletin, 94, 181-184.
5. Helmreich, R. L. (1984). Cockpit management attitudes. Human Factors, 26, 583-589.
6. Spence, J.T., Deaux, K., & Helmreich, R.L. (1985). Sex Roles in Contemporary American Society. In G. Lindzey & E. Aronson (Eds.), Handbook of Social Psychology, Third Edition. (pp. 149-178). Reading, MA: Addison Wesley.
7. Helmreich, R. L. & Siem, F. M. (1985). Cockpit management attitudes: II. Positional, organizational and personality factors. NASA/University of Texas technical report.
8. Helmreich, R.L. (1986). Pilot selection and performance evaluation: A new look at an old problem. In G.E. Lee (Ed.), Proceedings of the Tenth Symposium: Psychology in the Department of Defense. Colorado Springs, CO: U.S. Air Force Academy USAFA-TR-86-1.
9. Chidester, T. (1986). Mood, sleep, and fatigue. In G.E. Lee (Ed.), Proceedings of the Tenth Symposium: Psychology in the Department of Defense. Colorado Springs, CO: U.S. Air Force Academy USAFA-TR-86-1.
10. Edwards, V. (1986). Flight deck management attitudes: A cluster analysis. In G.E. Lee (Ed.), Proceedings of the Tenth Symposium: Psychology in the Department of Defense. Colorado Springs, CO: U.S. Air Force Academy USAFA-TR-86-1.
11. Helmreich, R.L., Sawin, L.L. & Carsrud, A.L. (1986). The honeymoon effect in job performance: Delayed predictive power of achievement motivation. Journal of Applied Psychology, 71, 1085-1088.

12. Helmreich, R.L., Foushee, H.C., Benson, R., & Russini, R. (1986). Cockpit management attitudes: Exploring the attitude-performance linkage. Aviation, Space and Environmental Medicine, 57, 1198-1200.

Invited Addresses producing formal papers

1. American Psychological Association, Washington, D.C., 1982, Explorations in achievement motivation.
2. American Psychological Association, Washington, D.C., 1982, Pilot Selection and Training.
3. Beyond pilot error - A symposium of scientific focus, Airline Pilots Association, Washington, D. C., 1983, Training - Behavioral and motivational solutions.
4. University of Illinois, 1983, A new look at achievement-related motives.
5. National Aeronautics and Space Administration, Ames Research Center, 1984, Mood, sleep, and personality: A study of cockpit crews.
6. Society of Experimental Social Psychology, 1983. The three faces of N-ACH.
7. Space Fair, Boston, Massachusetts, 1985. The role of psychologists in future space flights.